1 week or more prior to delivery.

CONSTRUCTION METHODS

472.60 General.

When directed by the Engineer to use bituminous concrete for patching, the Contractor shall obtain Class I Bituminous Concrete material as required under Section 460. If this material is not available, the Contractor may then use the material specified hereof in Section 472.

The bituminous concrete shall be laid to the thickness directed and compacted to the satisfaction of the Engineer.

COMPENSATION

472.80 Method of Measurement.

Bituminous Concrete for Patching will be measured as required in Section 460.

472.81 Basis of Payment.

Bituminous Concrete for Patching will be paid for at the contract unit price per metric ton complete in place. This price will include full compensation for the satisfactory removal and disposal of the material at a later date, if required, except as follows:

When the required bituminous concrete patching material is placed in areas of proposed roadway excavation, the removal and satisfactory disposal of the patching material will be paid for under the item of Roadway Earth Excavation.

472.82 Payment Item.

472.	Bituminous Concrete for Patching	Metric Ton

SECTION 476

CEMENT CONCRETE PAVEMENT

DESCRIPTION

476.20 General.

This work shall consist of a pavement composed of air entrained Portland cement concrete, plain or reinforced as specified, constructed on an approved foundation in accordance with these specifications and in close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

MATERIALS

476.40 General.

Materials shall meet the requirements of the following Subsections of Division III, Materials:

Concrete, (Air Entrained) 35 MPa - 40 mm - 400 kg	M4.02.00
Scored Concrete Pavement, (Air Entrained) 35 MPa - 20 mm - 420 kg	M4.02.00
Steel Reinforcement	
Reinforcing Bars	M8.01.0
Welded Steel Fabric	M8.01.2

Steel Bar Mats	M8.01.3
Tie Bars and Bolts	M8.01.4
Load Transfer Assembly	M8.14.0
Preformed Joint Filler	M9.14.0
Joint Filler Compound	M3.05.0
Polyurethane Joint Sealer	M9.14.3
Asphaltic Paint	
RC-70	M3.02.0
RS-1	M3.03.0
Curing Materials	
Impervious Liquid Membrane	M9.06.5
Waterproof Paper	M9.06.0
Burlap	M9.06.3
Polyethylene Coated Burlap	M9.06.4
White Polyethylene	M9.06.1B
Base Stabilization Materials	
Portland Cement	M4.01.0
Bitumen	M3.02.0

Fine aggregate for use in concrete to be placed with a slip-form paver shall meet the grading requirements as specified for fine aggregate for cement concrete except that the maximum passing the 150 micrometer sieve may be increased to 10% and a maximum of 4% passing the 75 micrometer sieve may be established in order to increase the cohesiveness of the cement concrete. Also, the concrete when tested in accordance with AASHTO Designation T 119 shall have a slump of not more than 50 millimeters nor less than 25 millimeters.

CONSTRUCTION METHODS

476.60 General.

The cement concrete pavement may be constructed by the Slip-Form Method or the Fixed-Form Method.

Equipment and tools necessary for handling material and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. Any equipment or tools which are not maintained in full working order or which, as used by the Contractor, prove inadequate to obtain the results prescribed, shall be improved or new equipment or tools substituted or added as directed.

Grade control survey and staking shall conform to Subsection 5.07. The Contractor shall furnish, set, and maintain all line and grade stakes for grading and paving.

476.61 Preparation of Grade.

The sub-base shall consist of gravel or dense graded crushed stone conforming to Section 401 or Section 402, or of soil cement, and shall be as specified on the plans. The sub-base shall be conditioned and perfected not less than 150 meters in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately ahead of the placing of the concrete.

Sub-base prepared for the slip-form method shall be placed to a compacted depth approximately 25 millimeters higher than the grade called for on the plans to allow for planing by approved mechanical means to the proper profile. It shall also be placed to a width 1 meter greater (500 millimeters on each side) than the required pavement slab width. After the sub-base has been placed and compacted to the required density, and will adequately support the subgrade machine and the slip-form paver, the track areas shall be cut to the proper elevation by the use of a mechanical form grading machine.

Behind the form grading machine the track areas shall be rolled to a smooth, firm, and uniform surface.

The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of a track mounted subgrade machine operation on the prepared track line or by other mechanical means approved by the Engineer. When concrete is placed, the surface of the sub-base shall not be above, nor more than 20 millimeters below the

plan subgrade elevation. If the density of the subgrade is disturbed by the subgrade machine, it shall be corrected by additional compaction before concrete is placed.

The sub-base, after being conditioned, shall provide a firm unyielding support which will not be displaced under the movement of the paver. If the sub-base is displaced by the movement of the paver to the extent that the finished pavement will be affected, the two areas that will support the slip-form paver tracks shall be stabilized as provided herein. The areas to be stabilized will be immediately outside the edge lines of the pavement slab on both sides and are each to be not less than 500 millimeters in width, measured from the exterior edges of the proposed pavement slab.

If cement is used for stabilization, the material to be stabilized shall be loosened and pulverized before any cement is added. Cement shall be uniformly spread on the loosened and pulverized material at the rate of approximately 22 kilograms per square meter. The final depth of stabilization shall be not less than
100 millimeters in the completed track area after it is brought to proper elevation. The exact amount of cement to be used to adequately harden the mixture of cement and subgrade material will be determined by the Engineer.

The cement and subgrade material shall be thoroughly mixed by means of a power driven mixer until the mixture is of a uniform color throughout the full required depth.

After the cement and subgrade material have been mixed, water shall be added to the mixture and mixing continued until the water is uniformly distributed throughout the mixture. The amount of water to be added will be determined by the Engineer. The moist mixture when ready for compaction shall be near its optimum moisture content.

The mixture shall be uniformly compacted for the full depth until it is firm and unyielding, and within
2 hours after the addition of the water. Compaction shall be with a 9 metric ton three wheeled or tandem roller, approved rubber-tired roller or approved mechanical vibrator.

After compaction, the surface of the area that will support the paver tracks shall be cut to true profile and elevation by approved mechanical equipment and then rolled to obtain a smooth, true surface.

The stabilization shall be protected from drying by the application of approved bituminous material (approximately 1.0 liter per square meter) or cover of straw, sand or earth. If straw, sand or earth is used for cover, it must be broomed off before the area is used in further operations. The curing material shall be applied immediately after final rolling and maintained for at least 2 days.

In lieu of the above method and procedure for stabilization of the track area, other proven methods and materials will be considered subject to equivalent and acceptable performance.

Regardless of the method, materials and procedures used, the burden or responsibility for the acceptability of work shall rest with the Contractor.

If stabilization of the track areas is required such stabilization will not be paid for separately, but will be included under Item 476, Cement Concrete Pavement.

Where fixed-form construction is specified, the use of a subgrade machine may follow form setting.

When side forms have been securely set to grade, the sub-base shall be brought to proper cross section. The fine grading shall be compacted by means of approved equipment to a condition similar to that of surrounding grade. A sub-base check template shall be used as a final check. The surface of the sub-base shall not be above nor more than 10 millimeters below the plan sub-base elevation. Any deviation from the required sub-base surface exceeding this tolerance shall be corrected.

The template shall span the width being paved and be supported on the side forms. It may be power or hand operated, with scratch teeth or pins which can be adjusted readily to the required cross section and supported in a frame of sufficient weight and strength to withstand the loads. The points of the teeth or pins shall be adjusted to be at the plan sub-base elevation. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade except that areas which are not more than 20 millimeters below sub-base elevation may be filled with concrete integral with the pavement. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed.

The sub-base shall be uniformly moist when the concrete is placed. When the sub-base is dry, it shall be sprinkled with as much water as can be readily absorbed immediately in advance of placing concrete. It shall also have been similarly sprinkled not less than 8 hours or more than 24 hours before concrete is placed thereon.

476.62 Forms and Form Setting.

Where fixed-form construction is specified, the straight side forms shall be made of metal and shall be furnished in sections not less than 3 meters in length. Forms shall have a depth equal to the prescribed edge thickness of the

concrete without horizontal joint and a base width equal to the depth of the forms but not less than 200 millimeters. Flange braces shall extend outward on the base not less than 2/3 the height of the form. Flexible or curved forms of proper radius shall be used for curves of 60 meter radius or less and be of a design acceptable to the Engineer. Satisfactory wooden forms, as approved by the Engineer, may be used for curves of 60 meter radius or less or where the design of pavement is such that the metal forms cannot be used. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved by the Engineer. The top face of the form shall not vary from a true plane by more than 1 millimeter in 1 meter, and the upstanding leg shall not vary from a true plane by more than 1 millimeter in 1 meter. The forms shall contain provisions for locking the ends of abutting form sections together tightly and for secure setting. Forms to be used for concrete which is to be furnished by hand shall have a base not less than 150 millimeters in width.

The foundation under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade which at the form line is found below established grade shall be filled to grade with granular material in lifts of 10 millimeters or less for a distance of 500 millimeters on each side of the base of the form, and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be joined neatly and tightly and staked securely with not less than 3 pins for each 3 meter section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked free from play or movement in any direction. If any play or movement of the forms occurs, additional pins shall be required by the Engineer. The entire base of forms shall be directly in contact with the finished sub-base. If a form does not have satisfactory bearing area for its full length, it shall be removed, the bearing area of sub-base reshaped and compacted, and the form replaced. Building of pedestals of earth or other materials upon which to reset the forms in order to bring them to the required grade is not permitted. Forms shall be set at least 150 meters in advance of the point of placing concrete. They shall be thoroughly cleaned and greased or soaped before concrete is placed against them. No excessive settlement or springing of forms under the finishing machine will be tolerated.

The forms shall be set to correct line and grade. Smooth alignment and grade shall be checked by sighting and with an approved 3 meter straight-edge. The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked. Use of a straight-edge will not be required on vertical curves. A mechanical tamper of approved type and design will be permitted for use in the preparation of a firm, even sub-base for form installation.

476.63 Batching and Mixing Concrete.

The materials shall be batched at a central plant. The batch plant site, layout, equipment, and provisions for transporting material shall be such as to assure a continuous operation of the paver employed on the project. The work shall be done in accordance with the relevant provisions of Subsection M4.02.08.

Concrete may be mixed at the site of construction or at a central point. Mixers shall conform to the applicable requirements of Subsection M4.02.09.

Concrete mixed at a central plant shall be hauled to the paving site by agitation trucks or other approved haul units in accordance with the relevant provisions of Subsection M4.02.10.

Concrete mixed completely in truck mixers in accordance with Subsection M4.02.10 (A-1), may be allowed when approved by the Engineer.

The Contractor shall obtain approval of his/her proposed central mix plant site, its capacity, concrete materials sources, hauling equipment, proposed haul routes, etc. prior to moving said equipment onto project.

Concrete mixed in pavers at the site shall be mixed for a period of not less than 60 seconds including transfer time but no less than 50 seconds, exclusive of transfer time, after all materials, except water, are in the drum. The mixer shall be operated at drum speed shown on the manufacturer's name plate. The manufacturer's guaranteed capacity of the mixer shall not be less than 1 cubic meter. Except by written permission of the Engineer, the mixer shall not be operated in excess of its guaranteed capacity nor by more than 10% above its rated capacity as shown on the standard rating plate on the machine, when operating on grades not exceeding 6%.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 20 seconds of the mixing period. The entire contents shall be removed from the drum before the succeeding batch is introduced. The inside of the drum shall be kept free from hardened concrete. The skip and throat of the mixer drum shall be kept clean and free of accumulation or encrustations of inert materials and the admission of these materials to the mixer shall be cause for rejection of the batch in which they are included. The concrete, as discharged from the mixer, shall be uniform in composition and consistency. If this condition is not produced with the maximum size of batch, the size of the batch shall be reduced or the mixing time increased, or both, until an acceptable mixture is obtained.

As required above, all materials except water shall be admitted to the mixer simultaneously and thereafter no additional amount of any ingredient shall be admitted to the mixer, except on specific instructions of the Engineer or his/her representative, for each individual batch. Such instructions shall not be given for more than three consecutive batches after which the proportions of the mix shall be correct prior to the initial charging of the mixer, and further, such instructions shall not relax the following restrictions concerning the retempering of concrete.

Retempering of concrete by the addition of water will not be permitted. The addition of water to the batch in the mixer after 10 minutes have elapsed after the initial charging, or the addition of water to the concrete after removal from the mixer, shall be construed as retempering. Batches of concrete prepared contrary to these restrictions shall be rejected and immediately removed from the site. The concrete shall be mixed only in the quantity required for immediate use and concrete not in place within 30 minutes from the time the ingredients were charged into the mixing drum, or that has developed initial set, shall not be used.

The concrete shall have a slump of between 40 and 75 millimeters if not vibrated, or between 25 and 50 millimeters if vibrated throughout, as measured in accordance with AASHTO Designation T 119.

Batches shall be discharged in a manner to facilitate placing the concrete in its final position with a minimum of rehandling and without damage to forms, concrete previously placed, or other parts of the work.

The interval between loads shall be controlled in order that concrete in place will not become partially hardened prior to placing succeeding batches and in no case shall it exceed 30 minutes. Plant capacity and transportation facilities shall be sufficient to insure delivery of concrete at the rate required.

Samples of concrete for test and test specimens will be taken from transportation units at the point of discharge or from the concrete in place as determined by the Engineer.

When cement concrete paving operations are done during cold weather, the stipulations as outlined in Subsection 901.72 shall apply.

476.64 Placing Concrete.

Concrete shall be placed only on an approved sub-base.

The Contractor shall notify the Engineer at least 24 hours in advance of placing the concrete. In the event the Contractor desires to operate after the daylight hours, the Contractor shall provide a lighting system sufficiently adequate to illuminate all of the operations to the satisfaction of the Engineer.

No finishing of the concrete will be permitted after daylight hours unless an adequate and approved lighting system is provided by the Contractor and operated in a satisfactory manner. Approval of the lighting system by the Engineer must be obtained prior to its use.

At least 150 meters of foundation shall have been prepared ahead of the mixer or concrete operations at all times. The depositing of concrete on excessively wet subgrades or sub-bases or a frozen foundation will not be permitted. No concrete shall be placed around manholes or other structures until they have been installed to the required grade and alignment.

During dry weather, when traffic on the foundation or adjacent roadways would deposit wind-blown dust and dirt on the freshly placed concrete before it can be protected, the Contractor shall sprinkle the foundation or adjacent roadways with water or otherwise apply satisfactory treatment to keep down the dust.

Unless otherwise permitted by the Engineer, all equipment used for mixing, hauling and placing the concrete shall be operated outside of the area being paved. Should operation of such equipment be permitted on the prepared foundation, suitable planks or platforms shall be provided and used for the equipment to run on, so that the foundation will be maintained in an approved condition.

The concrete shall be deposited on the grade in such a manner as to require as little handling as possible. Concrete shall be distributed in such a manner that when consolidated and finished, the slab-thickness and surface grade

required by the plans will be obtained at all points. Unless truck-mixers, truck-agitators, or nonagitating hauling equipment demonstrate that they will discharge concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade in such a manner as to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads except as specified under Subsection 476.68 for construction joints. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

The concrete shall be deposited carefully at and around contraction and expansion joints. It shall be shoveled against both sides of expansion joints simultaneously, maintaining equal pressure on both sides. Care shall be taken that the concrete is worked under all metal parts of the load transfer assemblies. The concrete shall not be dumped directly upon or against the joints in any manner which displaces the load transfer assemblies or joint material from the true position.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane may be opened to traffic when curing operations have been completed provided that beam tests show that the concrete has attained a modulus of rupture of at least 3.8 megaPascals. Curing operations will not be considered completed unless a curing period of at least 7 days has elapsed since the concrete was placed. However, the pavement may be used at the end of 5 days if only rubber-tired finishing equipment is permitted to operate upon it and the concrete has attained a modulus of rupture of at least 3.8 megaPascals.

When high early strength concrete is used, mechanical equipment may be operated upon the pavement after a shorter period of curing or as beam tests show that the concrete has attained a modulus of rupture of at least 3.8 megaPascals.

Pavers will not be permitted to operate on the finished pavement unless permission is given by the Engineer.

Gaps in the pavement for crossovers will not be permitted. Should crossings be necessary, suitable bridging of slabs or sand cushioning will be provided, as approved by the Engineer.

476.65 Spreading and Strike-Off of Concrete.

As soon as concrete has been placed on the sub-base, it shall be immediately struck-off accurately, by means of an approved mechanical spreading device, leaving a surface uniform in texture, true to grade, elevation and contour. The strike-off shall be so adjusted for elevation that when the concrete is consolidated, as herein designated, sufficient material remains above grade as is required for the final finished surface of the pavement.

When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck-off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck-off and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense.

A. Slip-Form Method.

The slip-form paver shall be an approved machine designed to spread, consolidate, screed, and float finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in conformance with the plans and specifications.

The slip-form paver shall be of the self-propelled type, equipped with crawler type tracks not less than 6.7 meters in length.

The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such distance that no appreciable slumping of the concrete will occur, and that necessary final finishing can be accomplished while the concrete is still within the forms.

The slip-form paver shall be adjustable as to crown and super-elevation and shall shape and compact the concrete to the required cross section as shown on the plans. Such adjustments shall be readily controllable for accuracy in transitions. No tractive force shall be applied to the machine except that which is controlled from the machine.

The concrete shall be of uniform consistency such that there will be no appreciable slumping at the edge of the pavement after the slip-forms have passed. The following tolerances on edge slump shall apply: edge slump, exclusive of edge rounding, shall not exceed 1 millimeter within 30 millimeters of the edge at the extreme outside limits of the concrete pavement: at the longitudinal joint along the pavement crown and along the longitudinal joint between the travel lanes and speed change lanes. The edges along the longitudinal joint between the two travel lanes of the same cross-slope shall be at true finish grade. Any deviation from these tolerances shall be corrected while the concrete is plastic.

The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

For reinforced pavement and where necessary, more than one machine and/or complimentary equipment will be allowed, subject to the Engineer's approval.

B. Fixed-Form Method.

The spreading machine shall be mechanical, self-propelled, and of an approved type. It shall be capable of spreading the concrete evenly between the side forms, without segregation, and without introducing thrust on the side form. It shall be equipped with a spreading device, adjustable in height for distributing the concrete longitudinally and transversely, and a blade adjustable in height to strike-off the concrete at the required elevation above or below the top of the side form.

Immediately after the concrete has been struck off, it shall be thoroughly consolidated against and along the faces of all forms and along the full length and around all parts of joint assemblies, by means of vibrators inserted in the concrete.

Vibrators, for full width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, subgrade, or side forms. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators.

When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.

Vibrators shall not cause the displacement of the side forms nor cause undue delay due to mechanical difficulties. Should these problems arise, they shall be removed from the work and be replaced by equipment meeting these specifications.

Surface vibrating apparatus shall be used only on the top course or layer of the pavement and must be completely out of use when moving over transverse joints or when spreading the bottom course of concrete in two-course construction. It shall not be operated where the surface of the concrete, as spread, is below the elevation of the finished surface of the pavement.

476.66 Placing Steel Reinforcement.

All reinforcing metal must be kept clean and free from dirt, oil, paint, grease, mill scale, loose or thick rust or any foreign material which could impair bond of the steel with the concrete. Welded sheet fabric and clipped bar mats shall be furnished in flat sheets and shall be handled carefully during the placing, and kept straight until installed.

The reinforcement shall be placed as shown on the plans. The reinforcement shall be placed so that the extreme longitudinal member will be located not more than 100 millimeters from the edge of the slab section and the ends of all longitudinal members shall extend to within 75 millimeters of the ends of the slab sections. Adjacent sheets of welded fabric and clipped bar mats shall be lapped as shown on the plans.

Mats or sheets of reinforcement shall be preformed in accordance with the schedule shown on the plans, and placed in the concrete by the strike-off method without chairs or other supporting devices. Laps between adjacent mats or sheets and positions of same with respect to longitudinal joints, transverse joints and edges of pavement shall be as shown on the plans.

Concreting operations shall be performed in a manner so that the mats and sheets will be left in required position.

When reinforced concrete is specified, or permitted by the Engineer, to be placed in one layer,the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory

means immediately after the concrete has been spread and struck-off.

476.67 Finishing Concrete.

Immediately after placement, concrete shall be properly finished. The sequence of operations shall be as follows: strike-off, consolidation, transverse screeding, longitudinal floating, straightedging, texturing and finally edging of formed joints. The machine method of finishing shall be employed, except that odd widths or shapes of slab may be finished by hand method.

The addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted.

A. Machine Finishing.

When the concrete paver is not designed to screed and float finish the freshly placed concrete, the surface shall be struck-off and screeded by an approved finishing machine.

The transverse finishing machine for the pavement shall be mechanical, self-propelled, and of an approved type. It shall be equipped with at least two oscillating screeds. It shall have an independent screed and traction speeds to permit the operator to choose a combination of speeds that will produce the required finish with the consistency of concrete being used. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish.

The transverse finishing machine shall consolidate and screed the concrete with no more than two passages over the slab, except with the special permission of the Engineer. The operation of the machine shall be controlled so as to prevent excess mortar and water from being worked to the top of the slab, and from forming a watery mortar in the roll of concrete in front of the screeds.

If excess mortar does form, it shall be removed from the site and wasted. It shall not, under any circumstances, be placed on the sub-base or shoveled ahead on top of the slab. Segregated particles of coarse aggregate which may collect in front of the screed shall be wasted outside the forms.

A uniform depth roll of concrete shall be maintained in front of the screeds at all times, in order to secure uniform consolidation and to prevent lifting of the screed by irregular amount or overload of concrete.

When vibration is permitted vibrators for full width vibration of concrete paving slabs shall meet the requirement herein of Subsection 476.65(B). If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along forms, at structures, and throughout the pavement, the Contractor shall furnish equipment and methods which will produce pavement conforming to the Specifications.

B. Longitudinal Finishing.

As soon as possible after the transverse finishing has been completed as specified above, the surface of the concrete shall be further smoothed and finished by use of an approved longitudinal float.

Mechanical Method - The float in contact with the pavement shall be at least 3.75 meters in length and at least 300 millimeters wide. The type of float and details of its construction shall be approved by the Engineer, and it shall be in good working condition.

The tracks from which the float operates shall be accurately adjusted to the required crown. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the Engineer on each transverse trip. The float shall pass over each area of pavement no more than twice except with the special permission of the Engineer. Any excess water or soupy material shall be wasted over the side forms on each pass.

Hand Method - When strike-off and consolidation are done by hand methods and longitudinal floating by hand is required the float shall be not less than 5 meters in length, not less than 250 millimeters in width, suitably stiffened against flexibility and warping and equipped with suitable handles. It shall be operated from bridges spanning the pavement. It shall be operated with a sawing motion parallel to the center line while passing gradually from one side of the pavement to the other. Movement ahead shall be in successive advances of not more than one-half the length of the float. Excess water or soupy material shall be wasted over the side forms of each pass.

C. Alternate Finishing and Floating.

As an alternative to the mechanical finishing and floating method in Subsection 476.67(A) and (B) preceding, the Contractor may use a long wheel base combination float-finishing machine in lieu of the transverse finishing machine and

longitudinal float, providing the combination machine can be adjusted to produce satisfactory results and final finishing is properly timed. Any combination of screeding, floating and finishing machines shall include at least two transverse oscillating screeds.

D. Hand Finishing.

Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs. Narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods.

The surface of the concrete shall be struck-off immediately after it is placed and leveled by means of an adjustable steel template 250 millimeters wide and 500 millimeters longer than the width of the pavement. A second adjustable steel template 200 millimeters wide and 500 millimeters longer than the width of the pavement shall be used directly behind this template. Both templates shall be constructed to produce pavement of the desired cross section and shall have sufficient strength to retain their shape under all working conditions. The templates shall be moved forward with a combined longitudinal and crosswise motion fully resting at all times on the forms, and during the operation, the distance between the two templates shall at no time exceed
3 meters. The template shall be used until a true surface is obtained. While the concrete is being struck-off with the first template, three or more men shall be at work leveling, spading and tamping the concrete in front of the template.

Consolidation shall be attained by the use of a suitable vibrator or other approved equipment.

After the concrete has been struck-off with the hand templates described previously, other finishing operations described as following the screeding by the finishing machines shall be carried out.

Straightedging operations following the screeding shall be sufficient to remove surface irregularities or produce a riding surface equivalent to that produced by machine operation.

Experienced skilled operators and concrete finishers shall be employed. Any laxity in this respect shall be cause for immediate suspension of concreting operations.

E. Finishing at Joints.

The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in Subsection 476.65. After the concrete has been placed and vibrated adjacent to the joints the machine shall be brought forward operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over, and beyond the joints causes segregation of concrete, damage to or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately
250 millimeters from the joint. Segregated concrete shall be removed from in front of and off the joint: the front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

The edges of the slabs on both sides of the transverse expansion joint shall be finished to the same grade. The top transverse edges of formed joints shall then be rounded to a radius of 3 millimeters by means of approved edging tools. The transverse edges of formed joints shall be rounded with an edging tool having a vertical leg of sufficient length to contact the vertical side of the preformed filler. The lateral edge adjacent to pavement already in place shall be rounded with an edging tool having a vertical leg 6 millimeters wide and slightly longer than that used on the first slab. Tool marks shall be eliminated.

The finishing of the concrete at joints shall be done from a bridge which shall not rest on the concrete at any point. The finishers shall use a short straightedge not less than 1.25 meters in length when finishing transverse formed joints to insure that both slab ends will be at the same elevation or grade.

F. Straightedge Testing and Surface Corrections.

Following the longitudinal finishing operations all remaining irregularities shall be eliminated by use of scraping straightedges 3 meters in length, equipped with handles 600 millimeters longer than the width of one lane. Straightedges shall be made of redwood or aluminum. For wood the cross section shall be
50 millimeters by 180 millimeters tapered from 180 millimeters depth at center to 100 millimeters depth at ends. For aluminum the preferred shape is the “T” section with bearing width of not more than 75 millimeters. For both metal and wood the approximate mass should be 13.5 to 16 kilograms for the 3 meter length exclusive of handle. The handle shall

be attached to form an angle of about 10 degrees with the horizontal so as to present a cutting edge when in operation.

The scraping straightedge shall be employed directly after the longitudinal finisher.

The straightedge shall be placed on the form or edge of completed pavement nearest the operator. The handle shall be lowered to knee height and pushed transversely over the pavement surface. When it reaches the opposite form or center of full width paving, the handle shall be raised to shoulder height and the straightedge drawn back across the pavement in the same path. Additional passes shall be made if all irregularities are not removed by these two passes. Each pass shall be lapped one-half of the length of the straightedge as the work progresses. Any depressions found shall be immediately filled with freshly mixed concrete struck-off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness.

Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross section.

Where a wood straightedge is used, the Contractor shall maintain a master straightedge on the job. Wood straightedges are required to be checked on the master straightedge twice a day, once in the morning before use and again at noon. Any variation from a true plane shall be corrected before further use.

G. Final Finish.

Following the scraping straightedges, the final surface texture shall be developed by use of a wet burlap strip dragged longitudinally over the pavement. The burlap shall be not less than 1 meter nor more than 2 meters wide without seams and the leading edge fastened to a wood pole for purpose of keeping burlap in proper position. The burlap shall be a minimum of 600 millimeters longer than the pavement width being dragged. At least 600 millimeters of the burlap drag shall be in contact with the surface when dragging the pavement. Generally, two such drags should be used so that the complete operation may be in a forward direction without backing up.

The drags shall be cleaned of mortar when necessary so as to maintain uniform and satisfactory surface texture. Drags that cannot be cleaned shall be discarded and new drags substituted. When not in use, the drag shall be removed from the pavement surface.

The surface of the concrete, after burlap drag operation, shall be uniform in appearance with a gritty texture, shall have the required grade and contour, shall be free from surplus water, rough and porous spots, irregularities, depressions and other objectionable surface features resulting from the improper handling of the tools. The entire operation shall be executed to the satisfaction of the Engineer.

Mechanically operated wire or plastic bristle brooms shall be used where specified to provide an adequate skid resistant surface.

H. Edging at Forms and Joints.

After the final finish has been completed, but before the concrete has taken its initial set, the edges of slabs along forms and at formed joints shall be carefully finished and tooled to form a smooth rounded surface of the radius required on the plans. Corners or edges of slabs which have crumbled and any areas which lack sufficient mortar for proper finishing shall be cleaned by removing all loose fragments and soupy mortar, and shall be solidly filled and finished with a mixture of correct proportions and appropriate consistence. Tool marks shall be eliminated and all edges shall be smooth and true to line.

The surface of the slab shall not be unduly disturbed by tilting of the tool during use. All concrete on top of the joint filler shall be completely removed.

476.68 Joints.

Joints shall be constructed of the types and dimensions and at the locations required by the plans, or specifications, or as directed by the Engineer. They shall be placed to a true alignment as shown on the plans or as directed. The sides of joints shall be protected during the curing period. Joint spaces shall be protected against infiltration of foreign materials before the time of sealing. All joints shall be sealed before the pavement is opened to any kind of traffic. Dowels, tie-bars and tie-bolts shall be prepared and placed across joints where indicated on the plans.

If joints become adulterated with dirt, sand, gravel, or other foreign material during the construction period, they shall be reopened, cleaned and resealed prior to opening the job to traffic. This shall be done in conjunction with final clean-up. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required rate, and he/she shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained

at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

The Contractor shall submit for approval by the Engineer his/her proposed equipment for lighting and sawing prior to commencing work on the project.

A. Longitudinal Joints.

Longitudinal joints shall consist of construction joints between adjacent lanes and surface groove joints when the paving is placed more than one lane wide. They shall be located as shown on the plans or as directed.

Deformed steel bars or tie-bolts of specified length, size, spacing and material shall be placed perpendicular to the longitudinal joints; they shall be placed by approved hand or mechanical methods or rigidly secured by chairs or other approved supports to prevent displacement. Tie-bars and tie-bolts shall not be painted or coated with asphalt or other material or enclosed in tubes or sleeves.

When fixed-forms are used, tie-bolts shall be placed across longitudinal construction joints as shown on the plans or as directed. Tie-bolts shall be installed in two major parts to form an integral tie-bolt unit. Such device, as approved, shall result in proper installation as specified, and shall conform to all standard requirements specified herein for strength and design.

Tie-bars in full width paving shall be of the size and length shown on the plans and placed at right angle to and across the locations of the longitudinal joint. The mid-point of the tie-bar shall be at the longitudinal joint. When supported above the fine grade before placing concrete, the tie-bars shall be at the mid-depth of the pavement. Tie-bars may be placed under the distributed reinforcement by approved hand or mechanical methods before the reinforcement is placed and before the top layer of concrete is placed. If placed under the distributed reinforcement, the tie-bars shall be not less than 70 millimeters nor more than
120 millimeters below the finished pavement surface.

Longitudinal construction joints shall extend for the full depth of the pavement, be perpendicular to the pavement surface and keyed and tied as shown on the plans. The upper edges of the slab shall be rounded as shown on the plans. The slab placed second shall be edged with a tool having a vertical leg 5 millimeters thick and longer than that used in the first slab. The joint shall be filled with sealing material.

All honeycombed areas on the vertical faces of longitudinal joints shall be cleaned with a wire brush and thoroughly wetted and patched with mortar of the same composition as that used in the pavement.

The faces of the concrete slabs at the longitudinal joints shall be painted with asphaltic material specified in Subsection 476.40 before the adjacent slab is placed against it.

Longitudinal surface groove joints shall be constructed by sawing with an approved concrete saw to the depth, width and line shown on the plans. The width of the cut shall not be less than 5 millimeters and the depth shall not be less than one-fourth of the pavement thickness plus 5 millimeters. Suitable guide lines or devices shall be used to assure cutting the joint on the true line as shown on the plans. The joint shall be sawed before any equipment or vehicles are allowed on the pavement. If sawing is done before the end of the curing period, the faces of the joint shall be cured as provided for transverse sawed joints. The joints shall be filled with joint sealer compound as specified under Subsection 476.40.

Where there is more than one longitudinal joint, the cutting of this joint shall be done by tandem sawing, which saws shall be fixed to assure lines parallel and true, as shown on the plans.

B. Transverse Expansion Joints.

Transverse expansion joints shall be constructed where shown on the plans or directed by the Engineer. They shall consist of a preformed filler 20 millimeters thick (476.40), a top sealing cap of poured joint filler compound (476.40) and an approved load transfer assembly (476.40).

The expansion joint filler shall be continuous from edge to edge shaped to the subgrade and to the keyway along the edge. It shall extend from the subgrade to 25 millimeters below the pavement surface.

Preformed joint filler shall be furnished in lengths equal to the paving width or equal to the width of one lane. Where more than one section is used in a joint, the section shall be securely laced or clipped together. Damage or repaired joint filler shall not be used unless approved by the Engineer.

A removable metal cap shall be placed over the top of the preformed joint during the concreting operations to maintain proper grade and alignment. Concrete shall be placed as specified and shall be carefully spaded against the joint filler. The metal cap shall be removed immediately after the final pass of the finishing machine. A suitable strip of the exact dimensions of the filler shall then be inserted in the joint as a guide and the concrete edged with a 3 millimeters

radius edging tool. The strip shall then be removed and any rough or torn places in the concrete shall be corrected.

Particular care shall be taken to keep the concrete in exactly the same plane on the two sides of the joint. No plugs of concrete shall be permitted anywhere within the expansion space.

C. Transverse Contraction Joints.

These joints shall consist of planes of weakness created by sawing grooves in the surface of the pavement at the locations indicated on the plans.

Approved load transfer assemblies shall be installed at each contraction joint as shown on the plans and in accordance with the Specifications.

When approved by the Engineer, a vibrating bar may be used to move coarse aggregate off the line of the saw cut. The vibrating bar shall be used only in plastic concrete and so as not to produce areas of segregated mortar.

The Contractor's sawing equipment and method of sawing shall be subject to the approval of the Engineer. The timing and sawing and the order in which joints are sawed shall be subject to such control by the Engineer as in his/her judgment is necessary to protect the pavement from ravelling, spalling, cracking, or other damage. Normally, contraction joints will be sawed progressively with an approved circular saw at not less than 6 nor more than 24 hours after finishing. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and the night regardless of weather conditions.

The pavement shall be cut for not less than 3 millimeters in width to a depth at least one-fourth of the pavement thickness.

Secondary saw cuts shall be made as necessary so that the final joint width is at least 10 millimeters or as shown on the plans. In the event of excessive relief of the joint, care should be taken to secure this minimum opening.

To control random cracking the Engineer may require that initial curing (for the first 24 hours) be done with wet burlap. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. All contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs.

D. Transverse Construction Joints.

Transverse construction joints shall be placed at the end of each day's work and when placing concrete will be interrupted for more than 30 minutes. No transverse construction joint shall be placed closer than 5 meters to another transverse joint. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 5 meters long, the excess concrete back to the last preceding joint shall be removed and disposed as directed.

Substantial temporary wood or metal bulkheads shall be used to form construction joints. Particular care will be taken to provide a good riding joint and hand finishing shall be kept to a minimum. Poor riding joints will be corrected.

When the construction joint is placed at a regular location of an expansion or contraction joint, a standard load transfer assembly will be used. When the construction joint is at other than the regular joint location, deformed bars will be used to create a bonded tie across the joint. Minimum tie steel shall be #25 metric round deformed bars, 1.2 meters long at 250 millimeters center to center.

E. Load Transfer Devices.

Dowels shall be held in position parallel to the surface and center line of the slab by a metal device meeting the requirements of Subsection 476.40 or shall be placed by an approved mechanical placing device.

The sub-base at the locations where expansion, contraction, and construction joint load transfer assemblies are to be installed shall be trimmed accurately to the required cross section and depth of pavement. Where used, the complete joint assembly shall be carefully placed. If the sub-base is trimmed too low or if there are any open spaces beneath the preformed joint filler, the joint assembly shall be removed, the sub-base correctly graded and tamped, and the joint assembly reset.

One-half the length of each slip-dowel bar of load transfer units shall be rendered bondless with a coat of either a graphite lubricant or a wax base grease meeting the requirements of Subsection M8.14.0. The graphite lubricant shall be applied by daubing, mopping or gloved hand to produce a thorough coating approximately 2 millimeters thick. Brushes shall not be used for the application of the graphite lubricant.

The wax base grease shall be pre-heated to temperatures of 75 °C to 90 °C and applied either by dipping or by brush to produce a coating approximately 2 millimeters thick.

Dowels shall be coated at least one hour before the concrete is placed around the dowel assembly.

The assembly shall be held in the required position at line and grade by metal stakes or pins throughout the operation of placing and striking-off the concrete. No concrete shall be placed unless the methods and devices used by

the Contractor for installing and securing the joint assembly, including any joint filler required, and finishing the joint meet with the approval of the Engineer. Immediately prior to depositing the concrete, the position of dowels shall be checked and the assemblies tightened if necessary. The installation of dowel assemblies and the placement of the surrounding concrete shall result in dowels tightly enclosed in concrete and parallel to both the pavement surface and center line at plan locations. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the plastic concrete by a mechanical device approved by the Engineer.

476.69 Numbering Slabs.

The pavement slabs shall be numbered consecutively as the work progresses, and the last slab placed each day shall be stamped with the date. The marking shall be on the right hand corner at the beginning of each slab, and so placed that it can be read traveling in the direction the pavement was laid. The figures and letters shall be 40 millimeters high and plainly and neatly stamped after the final finish of the concrete as directed. When two or more paver mixers are working, the distinguishing letter for each mixer shall be stamped adjacent to the number.

476.70 Surface Test.

The entire surface shall be checked while the concrete is still plastic with an approved metal straightedge 3 meters in length, and any deviation from the general surface shall be corrected at once. The surface shall be checked again immediately after the removal of the burlap where an initial burlap covering is used, or at the end of 72 hours where 72 hour covering is used. The straightedge shall be placed at several points across the pavement parallel to the centerline and shall be advanced in 1.5 meter steps. Areas showing high spots of more than 3 millimeters but not exceeding 10 millimeters in 3 meters shall be marked and immediately ground or rubbed down with an approved tool to an elevation where the area or spot will not show surface deviations in excess of 3 millimeters when tested with a 3 meter straightedge. This grinding or rubbing shall be conducted carefully so as to avoid loosening coarse aggregate or otherwise damaging the slab.

Where the departure from correct cross section exceeds 10 millimeters, the pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be not less than 5 meters in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 5 meters in length shall also be removed and replaced.

476.71 Curing.

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods. In all cases in which curing requires the use of water, the curing shall have prior rights to all water supply or supplies. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or a lack of water adequate to take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period. Whenever fixed-forms are not used, exceptional care shall be taken in the use of paper or burlap to prevent any damage to the unsupported edges of the pavement. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the pavement.

A. Moist Curing.

Initial Curing – Strips of burlap saturated with water shall be placed on the fresh concrete surface carefully so as to avoid marring, and the strips shall overlap not less than 75 millimeters. This burlap shall be kept thoroughly and continuously wet by sprinkling it with a fine spray of water until it is removed. Initial curing with wet burlap shall be for a period of not less than 24 hours. Burlap which has been used for any purpose other than curing concrete shall not be used.

Final Curing – Following completion of initial curing the curing shall be continued using an additional layer of burlap or cotton mats. This double layer shall remain in place and shall be kept thoroughly and continuously saturated with water for a period of not less than 5 days.

Cotton mats may be used for final curing if approved by the Engineer. Such covering shall be as effective in preventing evaporation of mixing water and controlling variance in temperature of the concrete as the two thicknesses of wet burlap. If cotton mats are used for final curing, the burlap shall be removed in such a manner that not more than 18

meters of pavement is exposed at one time, followed at once by application of cotton mats.

B. Waterproof Paper Curing.

The top surface and sides of the pavement shall be entirely covered with waterproof paper. Each paper cover shall be not less than 6 meters or more than 20 meters in length, and shall be of such width that, when in place, it will extend to at least 500 millimeters beyond the edges of the slab to be covered.

Paper covers may be furnished in widths corresponding to that of the slab provided supplemental stringer sheets, at least 500 millimeters wide are used, in which case such sheets shall be placed along the edge of the slab under the paper covers. On removal of forms the paper shall be brought down over the slab side and held with a continuous bank of earth. The junctions between the paper covers shall be lapped approximately 300 millimeters and held in place with a bank of earth.

All rips or holes occurring in the paper covers while in use shall be immediately repaired with a sealed patch to render them airtight. Covers which have become damaged or soiled to the extent that they will not provide satisfactory curing or will mar the concrete shall not be used.

The paper shall be left in place for a period of 72 hours or longer, if necessary to obtain the required strength. The surface of the pavement shall be moist when the paper is placed.

C. Impervious Membrane Curing.

After finishing operations have been completed, and immediately after the free water has left the surface, the surface of the slab shall be completely coated and sealed with a uniform layer of white pigmented curing compound. The compound shall be applied in a 2-coat continuous operation and at a total coverage of not less than 0.3 liters per square meter of surface.

The compound shall be applied by means of a mechanical pressure sprayer mounted on a self-propelled carriage. The compound shall form a uniform, continuous, coherent film that shall not check, crack or peel and shall be free from pin holes, or other imperfections. If discontinuities, pin holes or abrasion exist, an additional coat shall be applied within 30 minutes to the affected areas. The equipment shall provide adequate stirring of the compound during application. Also, wind protection to the spray fog shall be provided by an adequate shield when the compound is applied to the pavement. The equipment for applying the compound shall be approved by the Engineer before work is started. Should the method of applying the compound not produce a uniform film, its use shall be discontinued and the curing shall be done by one of the other approved methods specified herein.

The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound.

Liquid membrane material shall not be placed on the faces of joints. Immediately after the contraction joints are sawed, they shall be protected and moist-cured with strips of waterproof paper or plastic. Ropes made of jute or cotton may also be used. The method used shall insure proper curing of the portion of the slab adjacent to the joints.

Immediately after the forms are removed, the entire area of the sides of the slab shall be coated with the curing compound at the rate specified for the pavement surface. This spraying shall be a continuous process, and waiting until all forms have been removed before making the application will not be permitted. Handspray equipment will be permitted for the application of the curing compound over the sides of the slab. Care shall be used to prevent coating the ends of sawed contraction joints. If hair checking develops before the curing compound can be applied, the concrete shall be moist-cured for at least 24 hours before applying any membrane curing compound. If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply a new coat of material to the affected areas, equal to that specified for the original coat. The treated surface shall be protected by the Contractor from injury for a period of at least 3 days. All traffic, foot or otherwise, will be considered injurious to the film of the applied compound. A minimum of foot traffic will be permitted on the dried film as necessary to carry on the work properly, provided any damage to the film is immediately repaired by the application of an additional coat of compound.

D. White Polyethylene Sheeting.

The general requirements for the use of white polyethylene sheets shall be those for waterproof paper curing in Subsection 476.71B.

E. Curing in Cold Weather.

During cold weather, when the air temperature may be expected to drop below 5 °C, a sufficient supply of loose dry hay or straw or other suitable blanketing material for covering shall be provided along the line of the work, and at any time when the air temperature may be expected to reach the freezing point during the day or night, the material so

provided shall be spread to a sufficient depth to prevent freezing of the concrete. The period of time such protection shall be maintained shall be not less than 5 days or until the concrete has hardened thoroughly. The use of such hay or straw does not take the place of the burlap or other covering specified herein, but shall be applied in addition to the covering. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

476.72 Removing Forms.

Forms shall not be removed for 12 hours after the concrete has been placed, or for a longer period if directed. Extreme care shall be taken in removing forms in order that no damage will be done to the concrete. Under no condition shall any bar, pick, or other tool be used which depends upon leverage on the concrete, for removal of the pins or forms.

As soon as side forms are removed and prior to sealing joints, the ends of all joints shall be opened and all mortar or foreign material shall be removed from the joint opening above the filler or other space as provided so that there will be complete freedom for required movement of the joint. After the forms have been removed, the side of the slab shall be cured as outlined in one of the methods indicated previously.

All holes or honeycomb shall be patched promptly with mortar, of the same composition as that used in the pavement, which has been allowed to set for about one-half hour after mixing. Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than 5 meters in length nor less than full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than
5 meters in length shall also be removed and replaced.

476.73 Sealing Joints.

Joints shall be sealed after curing and before any kind of traffic is permitted on the pavement.

The sealing of joints shall be undertaken only when the atmospheric temperature is above 5 °C, and when the weather is not foggy or rainy.

Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including curing compound, by means of a mechanical, power-operated concrete grooving machine or a power wire brush. The concrete grooving machine or wire brush shall be operated in such a manner that the vertical faces of the concrete in the joint opening will present thoroughly clean concrete surfaces for application of the joint sealing compound. Following this operation, each joint shall then be further cleaned by means of a powerful jet of compressed air.

No joints shall be filled when there is any free water in or adjacent to the joints. Joint walls and all surfaces to which the sealing compound is to be applied shall be surface dry for at least 3 hours prior to placing. No joints shall be sealed until the joints have been approved by the Engineer as being clean and dry in accordance with the foregoing provisions.

Joints shall be sealed with an approved joint sealing compound conforming to Federal Specifications for Sealer, Hot-Poured Type for Joints in Concrete (SS-S-164), or an approved elastic open-cell compression seal (M9.14.3).

The melting devices used for heating the joint sealing material shall be of the double boiler, indirect heating type using high flash oil for heat transfer. Constant mechanical agitation during the entire melting period shall be provided and no material shall be subjected for more than 60 minutes to the high temperature required for melting of the material. Positive temperature control (preferably by thermostat) of the heating medium of the sealing compound shall be provided at all times.

Hot-poured sealing compound shall not be subjected to temperatures in excess of 230 °C at any stage of the melting operation. Sealing material that has remained in the kettle in a molten state overnight will not be acceptable for use.

Hot-poured filler for use in sealing all joints, except expansion joints, shall be applied under pressure. When hot-poured filler is applied under pressure, the material shall be applied by means of a heavy duty air operated pump, or other approved device. The material shall be discharged through a suitable nozzle in such a way as to fill the joint opening solid and uniformly in a neat and workmanlike manner.

When the atmospheric temperature at the time of sealing is below 10 °C, the surface of the sealing compound in the finished joint shall be not less than 5 millimeters below the level of the pavement surface.

The sealing shall be done in such a manner that the material will not be spilled on the exposed surfaces of the

concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

In the event paving and construction operations must close down in the Fall because of cold weather and the contract cannot be completed until the following year, the Engineer shall require the Contractor to clean and seal all joints in the part of the pavement completed at the time of the shut-down, in the manner prescribed in this Specification. Under no circumstances shall any joint remain unsealed between the period of shut-down in the Fall and resumption of construction in the Spring.

476.74 Protection of Pavement.

The Contractor shall erect and maintain suitable barricades and employ watchmen to exclude traffic from the newly constructed pavement for the period herein prescribed. These barriers shall be so arranged as not in any way to interfere with or impede public traffic on any lane intended to be kept open. Necessary signs shall be maintained by the Contractor clearly indicating the open lanes to the public. When it is necessary to provide for traffic across the pavement, the Contractor shall construct at his/her entire expense, immediately after the finishing of the concrete, the necessary bridges over the pavement clear of the forms and at least
75 millimeters clear of the concrete and sufficiently strong to carry the traffic. The Contractor shall maintain these bridges until the concrete has attained the strength required in these Specifications for opening to traffic.

Prior approval shall be obtained from the Engineer for crossing of existing structures with the paving train.

When fixed-forms are not used, the Contractor shall be required to have available at all times, materials for the protection of the edges and surface of the unhardened concrete in order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than
50 millimeters and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement.

An adequate quantity of the materials described above shall be available, loaded on vehicles which can be promptly driven or towed to the scene of paving operations and be located not more than one kilometer from the place where the paving operations are in progress.

When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

The Contractor shall have on hand at the paving site sufficient burlap or paper to cover at least
600 square meters of freshly laid pavement as a protection against sudden thunder showers or heavy downpours of rain.

Any part of the pavement damaged by traffic or other causes occurring prior to its final acceptance shall be repaired or replaced by and at the expense of the Contractor in a manner satisfactory to the Engineer. The Contractor shall protect the pavement against both public traffic and the traffic caused by his/her own employees and agents. The pavement shall be so protected until the beam test shows a strength of at least
3.8 megaPascals.

476.75 Opening to Traffic.

Upon completion of curing operations as specified, the pavement may be opened to traffic provided that beam tests show that the concrete has attained a modulus of rupture of at least 3.8 megaPascals. However, curing operations will not be considered completed unless a curing period of at least 7 days has elapsed since the concrete was placed.

Where high-early strength concrete is used, the pavement may be opened to traffic after a shorter period of curing or as beam tests show that the concrete has attained a modulus of rupture of at least
3.8 megaPascals.

476.76 Test Specimens.

Test specimens shall conform to the requirements of Subsection M4.02.13. They will be taken in the field from batches used in the pavement to determine the adequacy of control of the materials, the proportioning and mixing of the concrete and compliance with the minimum strength requirements. Test beams shall be
150 millimeters x 150 millimeters x 900 millimeters in length and shall be made, cured, and used in accordance with

AASHTO Designations T 23 and T 97. At least two beams shall be made for each 1500 square meters or fraction thereof of pavement placed.

Payment for the forms, material and assistance as the Engineer may require to make, cure and test the field specimens will not be paid for directly but shall be included in the contract unit price for the pavement.

476.77 Tolerance in Pavement Thickness.

It is the intent of these Specifications that the pavement shall be constructed in accordance with the thickness shown on the plans. Before final acceptance of the work or during the progress of the work, as may be advisable or necessary, the thickness or depth of concrete pavement will be determined by cores taken by the Contractor under the direction of the Engineer or his/her designee, and unsatisfactory work shall be repaired, replaced, or will be paid for at an adjusted unit price. Where any pavement is found deficient in thickness, the following rules relative to replacement of the faulty pavement and adjustment of unit price shall govern.

The thickness of the pavement will be determined by average caliper measurement of cores tested in accordance with AASHTO Designation T 48.

For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined as not more than 300 meters of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. A traffic lane is defined as being between longitudinal joints or between a longitudinal joint and a pavement edge. The last unit in each lane shall be 300 meters plus the fractional part of 300 meters remaining.

One core will be taken at random in each unit by the Contractor.

When the measurement of the core from a unit is not deficient by more than 5 millimeters from the plan thickness, the pavement in the unit represented will be paid for at full unit price.

When such measurement is deficient by more than 5 millimeters but less than 10 millimeters, two additional cores at intervals of not less than 100 meters will be taken. The thickness of the unit will be considered to be the average of the three cores provided none is deficient by 10 millimeters or more. Payment for the pavement in the unit will be at an adjusted unit price as provided in Subsection 476.81.

In calculating the average thickness of the pavement, measurements in excess of the specified thickness will be considered as the specified thickness. Measurements which are less than the specified thickness by 10 millimeters or more will not be included in the average.

When any core is deficient by 10 millimeters or more, additional cores will be taken at 7.5 meter intervals in each direction until a core is found in each direction that is deficient by less than 10 millimeters. Each such exploratory core will represent the depth of 7.5 meters of pavement one traffic lane in width. The pavement so represented will be deducted from the unit of pavement being measured and the remaining area cored and measured as described previously.

Pavement deficient by 10 millimeters or more but less than 20 millimeters may be accepted by the Engineer at no payment to the Contractor. However, the Contractor may, at his/her own expense, remove and replace the pavement, which will then be cored and measured for payment as herein provided.

Pavement deficient by 20 millimeters or more shall be removed and replaced by the Contractor at his/her own expense. Payment for such replaced pavement will be as provided herein.

Other areas such as intersections, entrances, crossovers, ramps, etc., will be considered as one unit and the thickness of each unit will be determined separately. Small irregular unit areas may be included as part of another unit. At such points as the Engineer may select in each unit, one core will be taken for each
1500 square meters of pavement, or fraction thereof, in the unit. Thickness of each unit will be determined as described previously except that when additional cores in any unit are required, they will be taken at locations as directed by the Engineer.

COMPENSATION

476.80 Method of Measurement.

Cement concrete pavement will be measured by the square meter and the quantity paid for shall be the number of square meters as determined by the actual area of the finished pavement, complete in place and accepted, but subject to adjusted proportional payment or non-payment as stated in Subsection 476.81 for all pavement areas found deficient in depth.

The width for measurement of the pavement shall be as shown on the typical cross sections, including additional widening where called for, or as otherwise directed in writing by the Engineer. The length will be measured *horizontally* along the center line of each roadway or ramp.

476.81 Basis of Payment.

Standard cement concrete pavement will be paid for at the contract unit price per square meter complete in place subject to price adjustments as set forth below. No additional payment over the contract unit price will be made for any pavement having an average thickness in excess of that shown on the plans. Average thickness shall be calculated as stated in Subsection 476.77. Where the average thickness of pavement is deficient in thickness by more than 5 millimeters, but less than 10 millimeters, payment will be made as follows:

CONCRETE PAVEMENT DEFICIENCY

Deficiency in Thickness, Determined by Cores	Proportional Part of Contract Prices Allowed
5 millimeters or less	100 percent
More than 5 millimeters, but less than 10 millimeters	80 percent
10 millimeters or more, but less than 15 millimeters	70 percent

Where core measurements indicate that the pavement is deficient in thickness by 10 millimeters but less than 20 millimeters the pavement may be accepted without any payment being made to the Contractor, or it may be replaced at the option of the Contractor with pavement of the specified thickness at his/her entire expense. If the deficiency in thickness is 20 millimeters or more, the Contractor shall be required to remove such deficient areas and replace them with cement concrete pavement conforming with all requirements of these Specifications and to the thickness shown on the plans. Such areas when accepted will then be duly included in the square meters for which payment shall be made at the contract unit price. The Contractor shall receive no compensation for materials or labor involved in removing and replacing deficient areas.

When high early strength concrete is specified at the direction of the Engineer, in order to expedite the opening of pavement to traffic, the high early strength will be obtained by means of an increase in the cement factor and a reduction of the water-cement ratio. The extra cement will be paid for at the actual unit cost per kilogram to the Contractor for the extra quantity of cement actually incorporated in the pavement, plus an allowance of 5% of the cost per kilogram, which cost shall include all equipment, labor storage, transportation and work incidental to its inclusion in the concrete and incorporation in the finished pavement.

476.82 Payment Items.

476.	Cement Concrete Pavement	Square Meter

SECTION 485

GRANITE RUBBLE BLOCK PAVEMENT

DESCRIPTION

485.20 General.

This item of work shall consist of furnishing and setting granite rubble block pavement on a sand cushion on a concrete base course in accordance with these specifications and in close conformity with the lines and grades shown on the plans or established by the Engineer.